Chapter 1

Introduction

1.1 Statement and the Signification of the Problem

Crude oil is arguably the most influential physical commodity in the world. It plays a prominent role in all economies because it provides energy for all kinds of human activity in forms of refined energy products, such as liquified petroleum gases (LPGs), gasoline, naphtha, jet/kerosene, gasoil, diesel and fuel oil, which are mainly used for household, industrial and the transportation sector. As a result, over the past 20-30 years, crude oil has become the largest traded commodity in the world, and affects many economies.

Rising crude oil price raise the cost of production of goods and services, transportation, and heating costs, among others. As a result, it provokes concerns about inflation and restricted discretionary spending of consumers and producers, and produces a negative effect in financial markets, consumer confidence, and the macroeconomy (see also, Mork (1994), Lee et al. (2001), Hooker (2002), Hamilton and Herrera (2004), Cunado and Perez de Garcia (2005), Jimenez-Rodriguez and Senchez (2005), Kilian (2008), Cologni and Manera (2008) and Park and Ratti (2008)).

Nowadays, the four major benchmarks in the world of international trading are: (1) West Texas Intermediate (WTI), (2) Brent, (3) Dubai and (4) Tapis. Crude oil prices are usually quoted in three different kinds of financial transactions. First, crude

oil is usually sold close to the point of production, and is transferred as the oil flows from the loading terminal to the ship Free on Board (FOB). Therefore, spot prices are quoted for immediate delivery of crude oil as FOB prices. Second, forward prices are the agreed upon price of crude oil in forward contracts. Finally, futures price are prices quoted for delivering in a specified quantity of crude oil at a specific time and place in the future at a particular trading centre.

Figure 1.1 presents the plots of daily crude oil spot, forward and futures price of Brent oil that fluctuates due to various historical situations, such as OPEC policy, world economic situation, uncertainty from wars and terrorism or political instability in the Middle East. Askari and Krichene (2008) found that during 2002-2006 these dynamics were dominated by strong upward drifts and frequently jumps, causing the oil market not to settle around a mean. While oil prices attempted to retreat following major upward jumps, there was a strong positive drift which kept pushing these prices upward. Therefore, volatility was high, thereby making oil prices very sensitive to small shocks and news.

Accurate modelling of volatility in asset returns is one of the major issues of concern in financial economics. Even though volatility is not the same as risk, when it is interpreted as uncertainty, it becomes a key input to many important financial applications such as investment, portfolio construction, option pricing, hedging and risk management (Poon and Granger (2003)). Therefore, in the literature, research in the volatility area has focused on such different properties of the return series as its time varying conditional moment, volatility clustering, asymmetric patterns, and particularly, volatility spillover patterns that are widespread in financial markets

(Milunovich and Thorp (2006)), energy markets, and stock markets (Sadorsky (2004)).

The volatility and volatility spillovers among spot, forward and futures markets are very important to both the government and the producers/markets in crude oil. From the government policy point of view, knowing the relationships between futures and spot clearly means a better alternative to market interventions such as imposing price stabilization policies. For processors/marketers, it provides a reliable forecast of spot prices in the futures to allow them to effectively manage their risks in the production and marketing process. It is also the interest of international market participants from many countries like the major crude oil exporter and importer. This study can provide international exporters/importers of commodities with some knowledge of the conditions in crude oil commodity futures and spot markets.

Theoretically, measurement of volatility of shocks to returns can be decomposed into predictable and unpredictable components. The predictable component can be classified into shocks to returns, or the conditional mean, and the volatility in the conditional variance. The volatility can vary over time, and also conditionally, as in GARCH-type models. Therefore, conditional volatility models have become widely used since the structural and statistical properties have been fully developed, and they are computationally straightforward (Manera et al. (2006)).

For volatility modelling, the success of GARCH model of Engle (1982) and Bollerslev (1986) have subsequently led to a family of univariate and multivariate GARCH models which can capture different behavior in financial returns, including time-varying volatility, persistence and clustering of volatility, and the asymmetric

effects of positive and negative shocks of equal magnitude. For example, univariate models are GARCH model of Bollerslev (1986), GJR or TGARCH model of Glosten et al. (1992) and EGARCH of Nelson (1991); multivariate models, specifying risk on one asset as depending dynamically on its own past and on the past of the other assets, are CCC model of Bollerslev (1990), DCC model of Engle (2002), VARMA-GARCH model of Ling and McAleer (2003), and VARMA-AGARCH model (McAleer et al. (2009)).

1.2 Objectives of the study

The objectives of this disertation are:

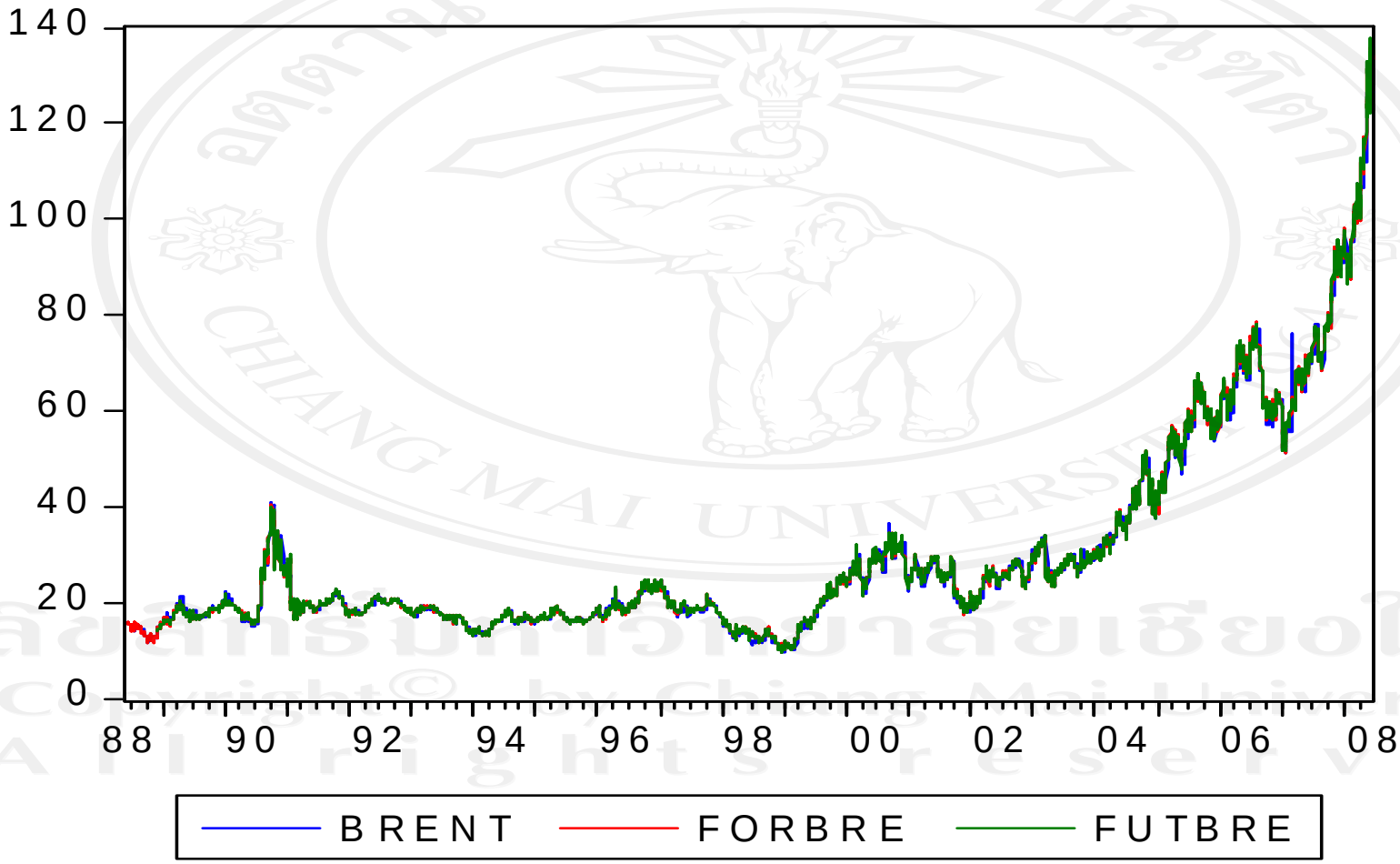
(1) to estimate univariate and multivariate conditional volatility models for the returns on spot, forward and futures prices for the Brent, WTI, Dubai and Tapis to aid in risk diversification on crude oil markets.

(2) to investigate the impartance of volatility spillover effects and asymmetrics effects of negative and positive shocks on the conditional variance when modelling crude oil volatility in returns on spot, forward and futures prices in Brent, WTI, Dubai and Tapis markets and across these markets.

(3) to forecast the conditinal correlation between returns in the markets and across markets to explain conditional correlations movement, which are important for portfolio construction and hedging, and

(4) to examine the volatility spillovers between crude oil futures returns and oil company stock returns for the major oil companies, which reveal the importance of the crude oil volatility on oil company stock volatility.

Figure 1.1 Daily oil spot prices of Brent from 13 June 1988 to 13 June 2008



1.3 Overview

For over a decade, volatility in asset returns is one of the major issues of concern in financial economics. It also is a key input to many important modern financial applications, such as investment, portfolio construction, option pricing, hedging, and risk management. In energy market, crude oil is the most important fundamental input for good and service production and transportation. It is not only traded in spot transaction but also in term of forward and futures contracts. Since crude oil is very sensitive to demand and supply, and shocks or news, so their prices are substantially volatile. Therefore in this dissertation the scope of study focus on crude oil returns volatility.

The purposes of the dissertation are to model univariate and multivariate conditional volatility, and volatility spillovers for different crude oil returns, namely spot, forward and futures returns, within and across different markets, namely Brent, WTI, Dubai and Tapis, and to examine volatility spillovers between crude oil futures returns and oil company stock returns for the major oil companies. According to these objectives, three papers are proposed in the proceeding of international conferences, and are reviewed as following.

First, the univariate and multivariate conditional volatility and conditional correlation models of spot, forward and futures returns from three major benchmarks of international crude oil markets, namely Brent, WTI and Dubai are estimated using the CCC model of Bollerslev (1990), VARMA-GARCH model of Ling and McAleer (2003), VARMA-AGARCH model of McAleer et al. (2009), and DCC model of Engle (2002). The results present the ARCH and GARCH effects for returns and show the presence of significant interdependences in the conditional volatilities across

returns for each market. The estimates of volatility spillovers and asymmetric effects for negative and positive shocks on conditional variance suggest that VARMA-GARCH is superior to the VARMA-AGARCH model. In addition, the DCC model gives statistically significant estimates for the returns in each market, which shows that constant conditional correlations do not hold in practice.

Second, in the world of international crude oil trading today, there are four major benchmark markets, namely West Texas Intermediate (USA), Brent (North Sea), Dubai (Middle East and Far East) and Tapis (Asia-Pacific), which their spot, forward and futures prices are likely to be highly correlated. This paper examines the volatility spillover effect in the returns on spot, forward and futures prices within and across the four markets, using three multivariate GARCH models, namely the CCC, VARMA-GARCH and VARMA-AGARCH models. Based on the asymptotic standard errors, the VARMA-GARCH and VARMA-AGARCH models presents evidence of volatility spillovers and asymmetric effects on the conditional variances for most pairs of series. In addition, using a rolling window technique to forecast the 1-day ahead conditional correlations between pairs of crude oil returns, shows that the conditional correlation forecasts exhibited vary over time and in both upward and downward trends.

Finally, the volatility spillovers between the returns on WTI crude oil futures and ten of oil company stocks, which comprise the “supermajor” group of oil companies, namely Exxon Mobil (XOM), Royal Dutch Shell (RDS), Chevron Corporation (CVX), ConocoPhillips (COP), BP (BP) and Total S.A. (TOT), and four other large oil and gas companies, namely Petrobras (PBRA), Lukoil (LKOH), Surgutneftegas (SNGS), and Eni S.p.A. (ENI), are investigated using alternative

multivariate GARCH models, namely the CCC, VARMA-GARCH and VARMA-AGARCH models. Estimates of the conditional correlations between the WTI crude oil futures returns and oil company stock returns are found to be quite low using the CCC model, while the VARMA-GARCH and VARMA-AGARCH models suggest no significant volatility spillover effects in any pairs of returns. The paper also presents evidence of the asymmetric effects of negative and positive shocks of equal magnitude on the conditional variances in all pairs of returns.